DRAFT VERSION: TOPEX Side B Sigma0 Calibration Table Adjustments: March 2002 Update

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Introduction

The TOPEX Altimeter Calibration Parameter Table, referred to as the Cal Table in the following, includes predicted updates for future cycles. At the Wallops Flight Facility of NASA's Goddard Space Flight Center we monitor trends in quantities related to the TOPEX altimeter's return power estimation and we propose, as appropriate, changes to the Cal Table. The most recent adjustment of the TOPEX Side B Cal Table was described in the document "TOPEX Side B Sigma0 Calibration Table Adjustments: September 2001 Update", by G.S. Hayne and D.W. Hancock III, 12 October 2001, available at *http://topex.wff.nasa.gov/docs* . That document included data through cycle 335 which ended on 2001 day 300.

Now we report a reassessment of the TOPEX Side B sigma0 calibration including data through cycle 345 which ended on 2002 day 035. Following sections of this memo will provide a brief review of Cal Table history, will show the Side B trends in power-related quantities, and then will describe a trend fit using three linear segments that will be the basis for a proposed new set of Cal Table sigma0 correction update values. This memo is an update to, and replacement for, the September 2001 version, and in this memo we will propose a new set of predicted values for the Cal Table.

Review of Cal Table History

Before launch we had expected that the Calibration Mode 1 AGC would be the basis for Cal Table updates, but the Cal Mode 1 AGC trend differed sufficiently from the over-ocean sigma0 cycle averages that we chose to base Side A Cal Table updates on the trend in the sigma0 cycle averages. Because the Cal Table corrections have already been applied to the sigma0 in the distributed GDR (Geophysical Data Record), it is important to remove these Cal Table corrections from the data before doing the trend assessment. All sigma0 trends discussed here are after the Cal Table corrections have

been removed. Basing the sigma0 correction on the trend of the uncorrected sigma0 itself is highly incestuous, and we tried to make the corrections based only on relatively long-term trends. The TOPEX Side A history is discussed in a document "TOPEX Sigma0 Calibration Table History for All Side A Data", by G.S. Hayne and D.W. Hancock III, 27 July 1999, available at *http://topex.wff.nasa.gov/docs* .

After the switch to Side B operation at the start of cycle 236, we observed that the Side B Cal Mode 1 AGC trend did appear to follow the trend of the sigma0 cycle averages. From the start of Side B operation until September 2001 the Side B Cal Table updates were based on the Cal Mode 1 AGC trend. By September 2001, however, we reported that the C-Band Cal Mode 1 AGC trends were showing some departure from the C-Band sigma0 trends, and we began to base the C-Band Cal Table updates on the C-band sigma0 trend. The Ku-band Cal Table updates were also based on sigma0 cycle averages so that we had a consistent procedure for both Ku- and C-band Cal Table updates.

Every change in the Cal Table used in TOPEX date processing at JPL is specified by a MOS Change Request (MCR) form, and Table 1 summarizes the MCRs which relate to sigma0 calibration. Table 1 also lists the approval dates and file creation dates listed on the file release form (there is one file release form for each MCR form).

Current Side B Trends of Power-Related Quantities

Figure 1 plots the cycle-averages of Side B Ku-band power-related quantities, and Figure 2 is the corresponding plot for the Side B C-band power-related quantities. The several Ku-band power-related quantities have been shifted by amounts given in the figure legends, so that all can be plotted on the same Ku-band vertical axis for time trend comparison. Likewise the C-band power-related quantities are shifted for plotting on a common C-band vertical axis. Figures 1 and 2 are somewhat busy, the consequence of trying to display several trends on a single plot figure.

There have been small seasonal corrections applied to the sigma0 cycle averages; these empirical corrections are based on the Side A sigma0 data. The seasonal corrections reduce slightly the vertical scatter of the sigma0 cycle averages, but do not change the overall trend of these data. In Figure 2 the Side B C-band sigma0 trend continues to deviate from the C-band Cal Mode 1 AGC trend, but the corresponding Ku-band trend deviations in Figure 1 are not as pronounced. We will continue to base the predicted Cal Table on the sigma0 cycle averages for both Ku- and C-band TOPEX Side B.

Line Segment Fits to Side B Sigma0 Trends

There was a spacecraft safe hold for most of cycle 256, and the Ku-band Cal mode AGC and sigma0 cycle averages showed an apparent change after the safe hold. The C-band showed much less change, if any, after the safe hold. We have decided to assume a possible discontinuity in performance of both the Ku- and C-band systems at cycle 256, and to fit both the Ku- and C-band Side B sigma0 cycle averages (seasonally-corrected) from cycles 236 - 255 by single straight-line segments.

In our September 2001 analysis of the data from cycles 257-335, we had arbitrarily decided to fit the sigma0 cycle averages by a function composed of two connected straight-line segments. This fitting function will be continuous in value, but will have a discontinuity in slope, and we let the least-squares fitting process pick the time (or cycle) location of the discontinuity. We continue that same fitting method now, for the data from cycles 257 through 345, and the results of the new sigma0 trend fitting are shown in Figure 3, in which both the sigma0 cycle averages and the trend fits have been plotted relative to their cycle 237 values. The shift to cycle 237 values is for convenience to allow both the Ku- and C-band data and fits to be plotted on a single vertical axis.

New Sigma0 Correction Values for Cal Table

Starting with the fitted sigma0 trends shown in Figure 3, the inverse of these trends will be used for proposed Cal Table updates. Figure 4 shows the Ku-band old and new Cal Table values; the "new" value is what this memo now proposes for TOPEX Side B. Figure 4 may be slightly misleading in its plotting an "old" Cal Table value for each cycle; actually the Cal Table entries list only the cycles at which there is a change in either the Ku- or the C-band (or both) sigma0 calibration. Up to the analysis reported in this memo the last change in Ku-band sigma0 Cal Table entry was at the start of cycle 338, and that value has "on hold" for processing of cycles 338 through 345. The new values are the cycle by cycle values on the straight-line segments labeled "new Ku-band Cal Table" in the figure.

One additional adjustment to the new Cal Table values is to impose a 0.03 dB quantization on the Cal Table updates. This is the same quantization that has been used in all of the TOPEX Cal Table entries to date, and the quantized new Ku-band Cal Table values are shown by the open triangles plotted in Figure 4. The new quantized Ku-band Cal Table values are listed in Table 2.

Figure 5 shows the C-band old and new Cal Table values, and the new quantized C-band Cal Table values are also listed in Table 2. Until the analysis reported here, the last "old" C-band Cal Table change was at cycle 340, with that value being held for processing cycles 340 through 345. Table 2

provides new Cal Table values out through cycle 375, with the values for cycles greater than 345 having been obtained by simple extrapolation of the rightmost fitted straight-line segments in Figure 3.

Table 3 lists the proposed Cal Table values for only those cycles at which there is a Cal Table change, and is produced from the same linear extrapolation used in generating the new values in Table 2. The first line of Table 3, for cycle 340, has the same Ku- and C-band Cal Table values which are currently "on hold" in the JPL production processing version of the Cal Table set by MCR 740, dated 17 September 2001. After cycle 340, the first change in Table 3 occurs at cycle 351 which begins on 2002 day 084 (25 March 2002).

We recommend that a new MCR should specify a new Cal Table containing values from Table 3, and that this MCR should be in place by the time of the start of processing of the cycle 351 data. Table 3 gives Cal Table values through cycle 398, but the sigma0 calibration will again be reassessed before that cycle.

Table 1. Summary of TOPEX AGC Calibration File Changes in Side B Operation.

From MCR Form			*From File Release Form*		*Additional Information*	
(1) **MCR #**	(2) **MCR Origination Date**	(3) **Comments on MCR Form**	(4) **File Creation Date**	(5) **Release Approval Date**	(6) **Comments on MCR actions and reasons**	(7) **Cycles Distributed, This MCR**
690	99/05/26 1999-146	After indicated parameter & constant changes, produce IGDrs and GDRs from all Alt-B data to date	1999/05/25 1999-145	1999/05/28	After initial Cal/Val activity, set constant Ku and C biases with values chosen to make smooth connection to Side A results	236 - 247
692	99/06/16 1999-167	see attachment request memo from P. Callahan	1999/06/17 1999-168	1999/06/17	C-band has a trend estimated from first 12 cycles (1st C-band change is at cycle 242), Ku-band has zero trend.	248 - 258
701	2000/01/10 2000-010	Begin use for cycle 259.	2000/01/13 2000-013	2000/01/13	Put in linear trend for Ku, and changed linear trend for C. Still assuming single linear trends from cycle 236 for Ku and for C.	259 - 276
703	2000/04/03 2000-094	Begin use for cycle 279 onward	2000/04/04 2000-095	2000/04/04	The correction trends of MCR 701 were getting too large, and a temporary freeze was put in to hold values constant from 278 forward.	- -
708	2000/07/18 2000-200	Begin use for cycle 288, reprocess 277-287; table change for cycle 236 forward, but cycles 236-276 won't be corrected at this time	2000/07/19 2000-201	2000/07/19	Side B trends (Ku particularly) show step-change at cycle 256; use two line segments (with step change at cycle 256) fitted to Cal 1 trends for producing Side B calibration table entries.	277 - 302
720	2000/12/06 2000-341	Begin use for cycle 303; reprocess SDR->IGDR for cycles 300-302	2000/12/07 2000-342	2000/12/07	Side B sigma0 trends have started to deviate from Cal 1 trends; now a three-segment line fit to sigma0 trends will be used for the Side B calibration table entries.	303 - 326
740	2001/09/17 2001-260	Begin use for cycle 327; reprocess IGDRs, GDRs for 327 forward	2001/09/17 2001-260	2001/09/17	The three-segment line fit (to sigma0 trends) was revised using data from approximately twenty cycles since the last trend fit, and a new set of Side B calibration table entries was produced.	327 - -

Table 2. TOPEX Side B Sigma0 Cal Table Values, in dB

TOPEX Data Cycle	*Ku-band Cal Table Value Used for GDR*	*C-band Cal Table Value Used for GDR*	*New Ku-band Cal Table value*	*New C-band Cal Table value*
236	0.45	0.55	0.45	0.52
237	0.45	0.55	0.45	0.52
238	0.45	0.55	0.45	0.55
239	0.45	0.55	0.45	0.55
240	0.45	0.55	0.45	0.55
241	0.45	0.55	0.45	0.55
242	0.45	0.55	0.45	0.55
244	0.45	0.55	0.45	0.58
245	0.45	0.55	0.45	0.58
246	0.45	0.55	0.45	0.58
247	0.45	0.55	0.45	0.58
248	0.45	0.61	0.45	0.61
249	0.45	0.61	0.45	0.61
250	0.45	0.61	0.45	0.61
251	0.45	0.61	0.45	0.61
252	0.45	0.61	0.45	0.61
253	0.45	0.64	0.45	0.64
254	0.45	0.64	0.45	0.64
255	0.45	0.64	0.45	0.64
257	0.45	0.64	0.30	0.64
258	0.45	0.64	0.30	0.64
259	0.27	0.64	0.30	0.64
260	0.27	0.64	0.30	0.64
261	0.27	0.64	0.30	0.64
262	0.24	0.64	0.30	0.64
263	0.24	0.67	0.30	0.64
264	0.24	0.67	0.30	0.64
265	0.24	0.67	0.27	0.64
267	0.21	0.67	0.27	0.64
268	0.21	0.67	0.27	0.64
269	0.21	0.67	0.27	0.64
270	0.18	0.70	0.27	0.64
271	0.18	0.70	0.27	0.64
272	0.18	0.70	0.27	0.64
273	0.18	0.70	0.27	0.64
274	0.15	0.70	0.27	0.64
275	0.15	0.70	0.27	0.64
276	0.15	0.70	0.27	0.64
277	0.21	0.58	0.27	0.64
279	0.21	0.58	0.24	0.64
280	0.21	0.58	0.24	0.64
281	0.21	0.58	0.24	0.64
282	0.21	0.58	0.24	0.64
283	0.21	0.61	0.24	0.64
284	0.21	0.61	0.24	0.64
285	0.21	0.61	0.24	0.64
286	0.21	0.61	0.24	0.64
287	0.21	0.61	0.24	0.67

TOPEX Data Cycle	*Ku-band Cal Table Value Used for GDR*	*C-band Cal Table Value Used for GDR*	*New Ku-band Cal Table value*	*New C-band Cal Table value*
288	*0.21*	*0.61*	*0.24*	*0.67*
290	*0.18*	*0.61*	*0.24*	*0.67*
291	*0.18*	*0.61*	*0.24*	*0.67*
292	*0.18*	*0.61*	*0.24*	*0.67*
293	*0.18*	*0.61*	*0.24*	*0.67*
294	*0.18*	*0.61*	*0.24*	*0.67*
295	*0.18*	*0.61*	*0.24*	*0.67*
296	*0.18*	*0.61*	*0.24*	*0.67*
297	*0.18*	*0.61*	*0.24*	*0.67*
298	*0.18*	*0.61*	*0.24*	*0.67*
300	*0.24*	*0.61*	*0.24*	*0.67*
301	*0.24*	*0.61*	*0.24*	*0.67*
302	*0.24*	*0.61*	*0.27*	*0.67*
303	*0.24*	*0.61*	*0.27*	*0.67*
304	*0.24*	*0.61*	*0.27*	*0.67*
305	*0.24*	*0.64*	*0.27*	*0.70*
306	*0.24*	*0.64*	*0.27*	*0.70*
308	*0.24*	*0.64*	*0.27*	*0.70*
309	*0.24*	*0.64*	*0.27*	*0.70*
310	*0.24*	*0.64*	*0.27*	*0.70*
311	*0.24*	*0.64*	*0.27*	*0.70*
312	*0.24*	*0.64*	*0.27*	*0.70*
313	*0.24*	*0.64*	*0.27*	*0.70*
314	*0.24*	*0.64*	*0.27*	*0.70*
315	*0.24*	*0.64*	*0.27*	*0.70*
316	*0.24*	*0.64*	*0.27*	*0.73*
317	*0.24*	*0.64*	*0.27*	*0.73*
318	*0.24*	*0.64*	*0.27*	*0.73*
319	*0.24*	*0.64*	*0.27*	*0.73*
320	*0.24*	*0.64*	*0.27*	*0.73*
321	*0.24*	*0.64*	*0.27*	*0.73*
322	*0.24*	*0.64*	*0.27*	*0.73*
323	*0.24*	*0.64*	*0.27*	*0.73*
324	*0.24*	*0.64*	*0.27*	*0.73*
325	*0.24*	*0.64*	*0.27*	*0.73*
326	*0.24*	*0.64*	*0.27*	*0.73*
327	*0.27*	*0.76*	*0.27*	*0.73*
328	*0.27*	*0.76*	*0.27*	*0.76*
329	*0.27*	*0.76*	*0.27*	*0.76*
330	*0.27*	*0.76*	*0.30*	*0.76*
331	*0.27*	*0.76*	*0.30*	*0.76*
332	*0.27*	*0.76*	*0.30*	*0.76*
333	*0.27*	*0.76*	*0.30*	*0.76*
334	*0.27*	*0.76*	*0.30*	*0.76*
335	*0.27*	*0.76*	*0.30*	*0.76*
336	*0.27*	*0.76*	*0.30*	*0.76*
337	*0.30*	*0.76*	*0.30*	*0.76*
338	*0.30*	*0.79*	*0.30*	*0.76*
339	*0.30*	*0.79*	*0.30*	*0.76*
340	*0.30*	*0.79*	*0.30*	*0.79*
341	*0.30*	*0.79*	*0.30*	*0.79*

TOPEX Data Cycle	*Ku-band Cal Table Value Used for GDR*	*C-band Cal Table Value Used for GDR*	*New Ku-band Cal Table value*	*New C-band Cal Table value*
342	*0.30*	*0.79*	*0.30*	*0.79*
343	*0.30*	*0.79*	*0.30*	*0.79*
344	*0.30*	*0.79*	*0.30*	*0.79*
345	*0.30*	*0.79*	*0.30*	*0.79*
346			*0.30*	*0.79*
347			*0.30*	*0.79*
348			*0.30*	*0.79*
349			*0.30*	*0.79*
350			*0.30*	*0.79*
351			*0.30*	*0.82*
352			*0.30*	*0.82*
353			*0.30*	*0.82*
354			*0.30*	*0.82*
355			*0.30*	*0.82*
356			*0.30*	*0.82*
357			*0.30*	*0.82*
358			*0.33*	*0.82*
359			*0.33*	*0.82*
360			*0.33*	*0.82*
361			*0.33*	*0.82*
362			*0.33*	*0.82*
363			*0.33*	*0.85*
364			*0.33*	*0.85*
365			*0.33*	*0.85*
366			*0.33*	*0.85*
367			*0.33*	*0.85*
368			*0.33*	*0.85*
369			*0.33*	*0.85*
370			*0.33*	*0.85*
371			*0.33*	*0.85*
372			*0.33*	*0.85*
373			*0.33*	*0.85*
374			*0.33*	*0.85*
375			*0.33*	*0.88*

Table 3. TOPEX Side B New Sigma0 Cal Table Value Changes Only.

TOPEX Data Cycle	New Side B Ku-band CalTable value, dB	New Side B C-band CalTable value, dB
340	0.30	0.79
351	0.30	0.82
358	0.33	0.82
363	0.33	0.85
375	0.33	0.88
386	0.36	0.91
398	0.36	0.94

Figure 1. Ku Side B Cycle-Avg Cal-1 & Cal-2 Delta AGC, Sigma0
(Cal Table Corrections Removed)

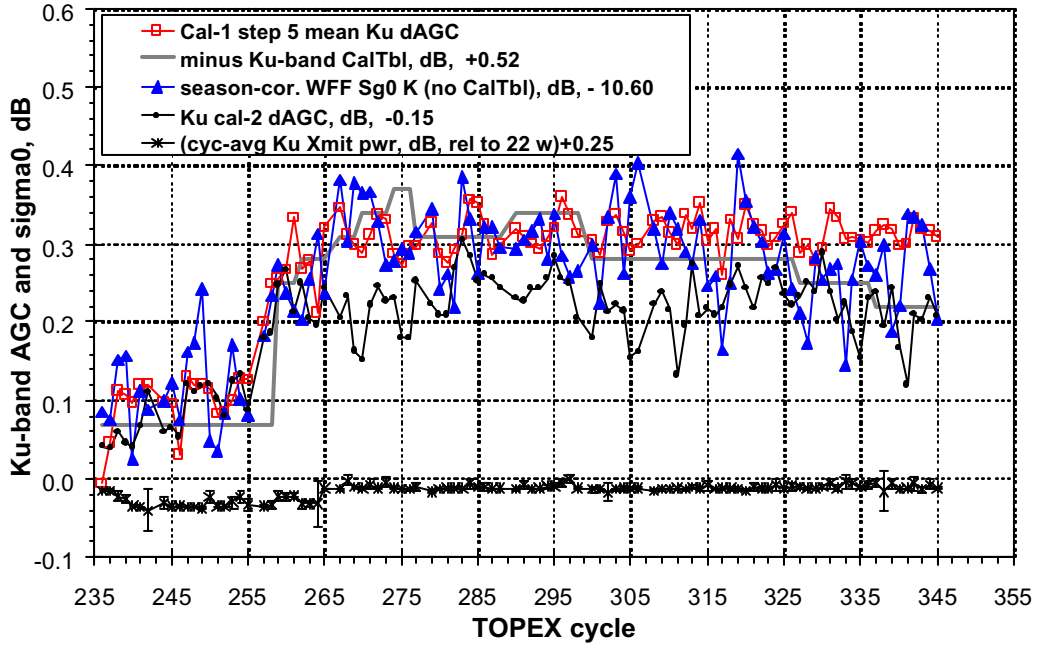

Figure 2. C-Band Cyc-Avg Cal-1 & Cal-2 Delta AGC, Sigma0
(Cal Table Corrections Removed)

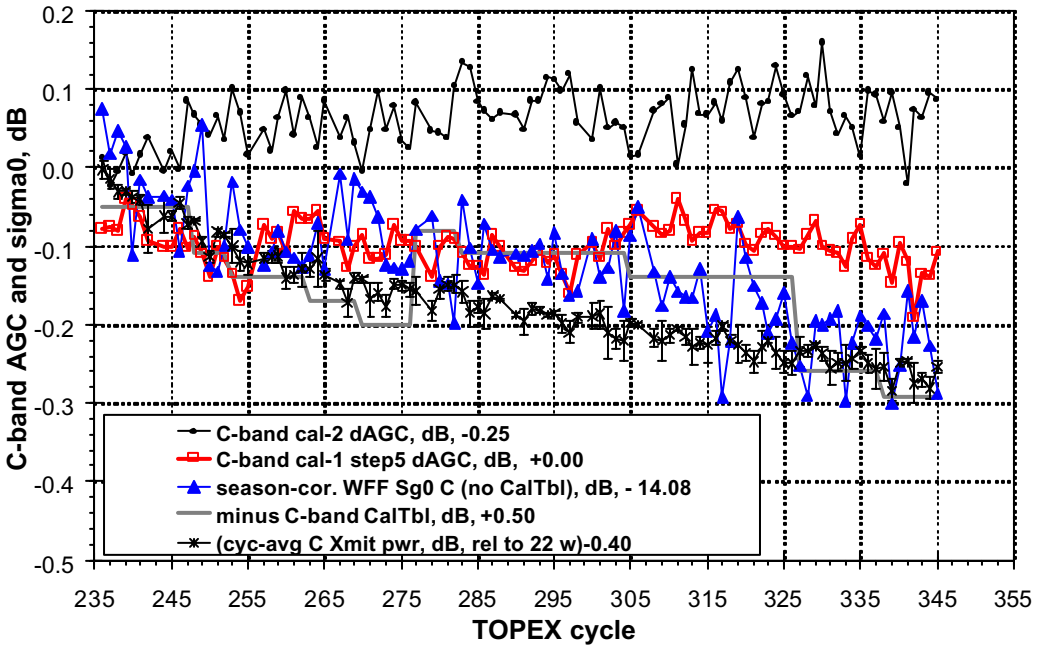

Figure 3. TOPEX Side B Sigma0 Trends

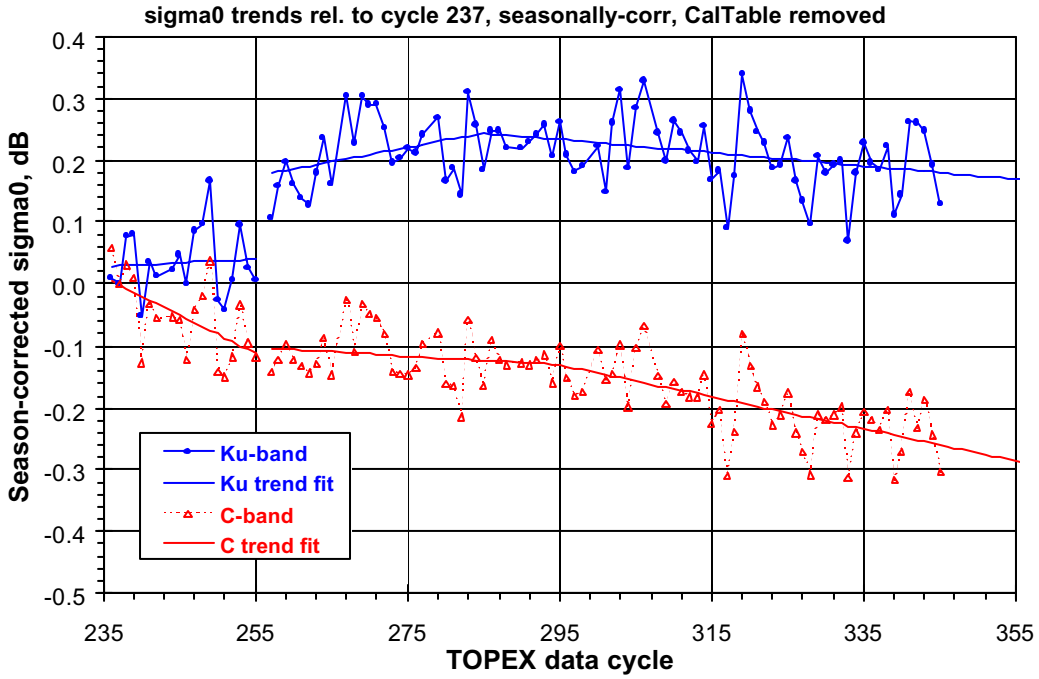

Figure 4. TOPEX Side B Old and New Ku-band CalTable Values

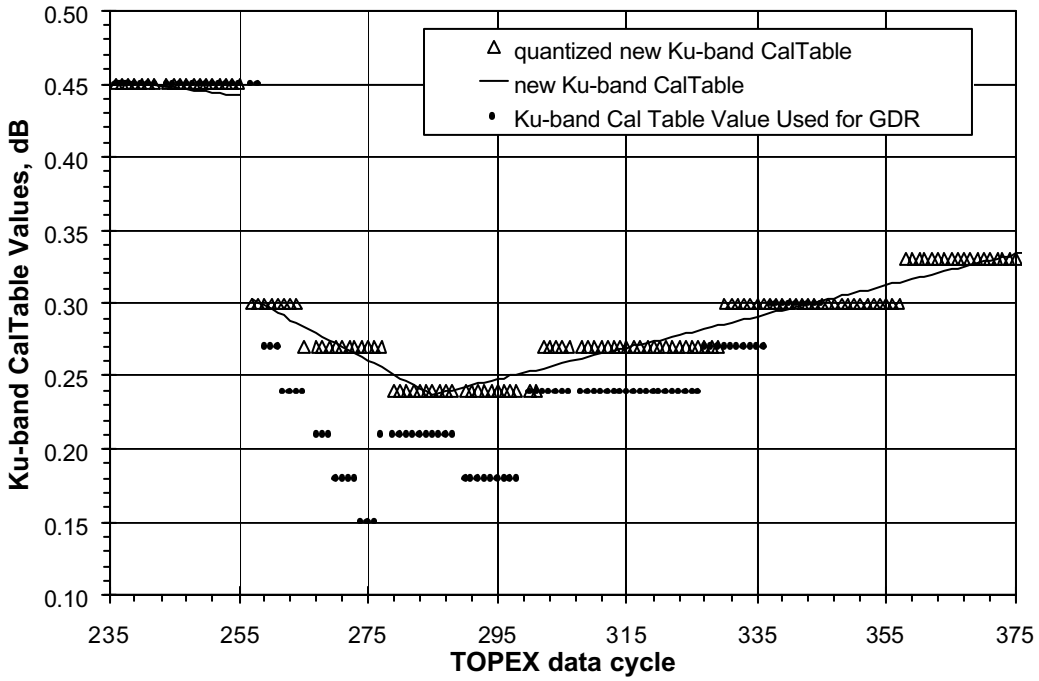

Figure 5. TOPEX Side B Old and New C-band CalTable Values